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THE PILE OF STRENGTH

CONCRETE

NORTH EASTERN CONSTRUCTION CO.

225 Fifth Avenue New York

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Representatives in Principal Cities

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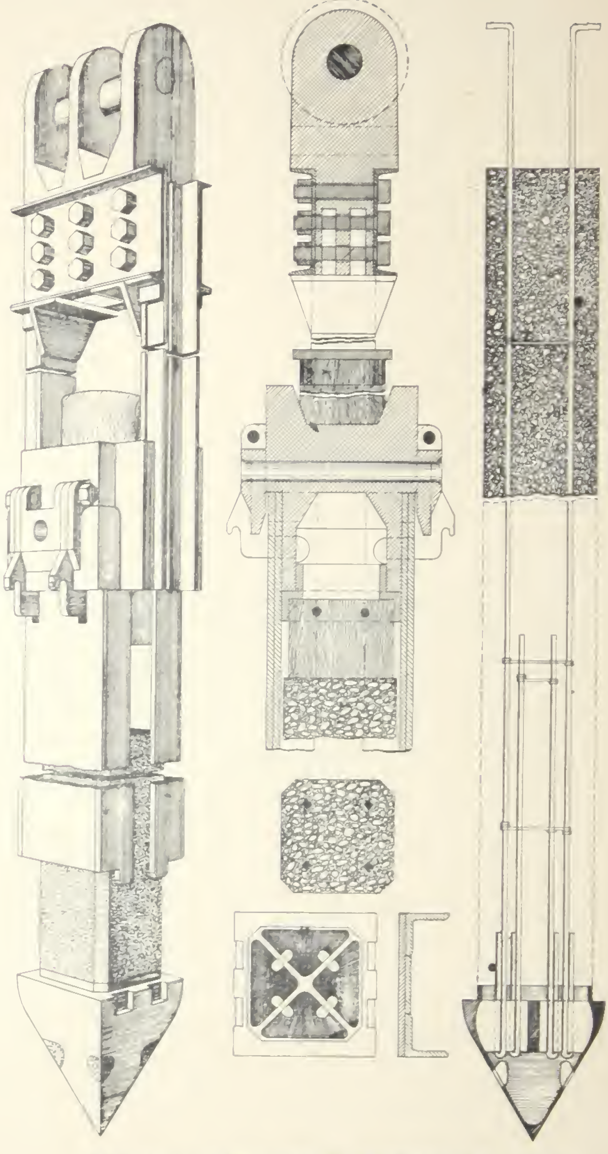
GIANT CONCRETE PILES

FOR

DEPENDABILITY

AND

ECONOMY.



DETAILS OF GIANT CONCRETE PILE

U.S. AND FOREIGN PATENTS PENDING

GIANT CONCRETE PILES.

THEY ARE MADE AND SEASONED BEFORE DRIVING. NO CUSHION IS EMPLOYED.

The drawings on opposite page show in detail the construction of Giant concrete piles and the apparatus by which they are driven except a steam hammer which occupies the space between pulling and driving heads.

This is a premoulded square shaft of concrete, driven from the point which is rigidly secured thereto by deformed steel bars at the time of pouring.

The pile is placed between steel driving channels which are in contact with the projecting point but which do not touch the concrete, and then driven.

After driving, the channels are withdrawn, one at a time, thus preventing any disturbance of the given position of the pile.

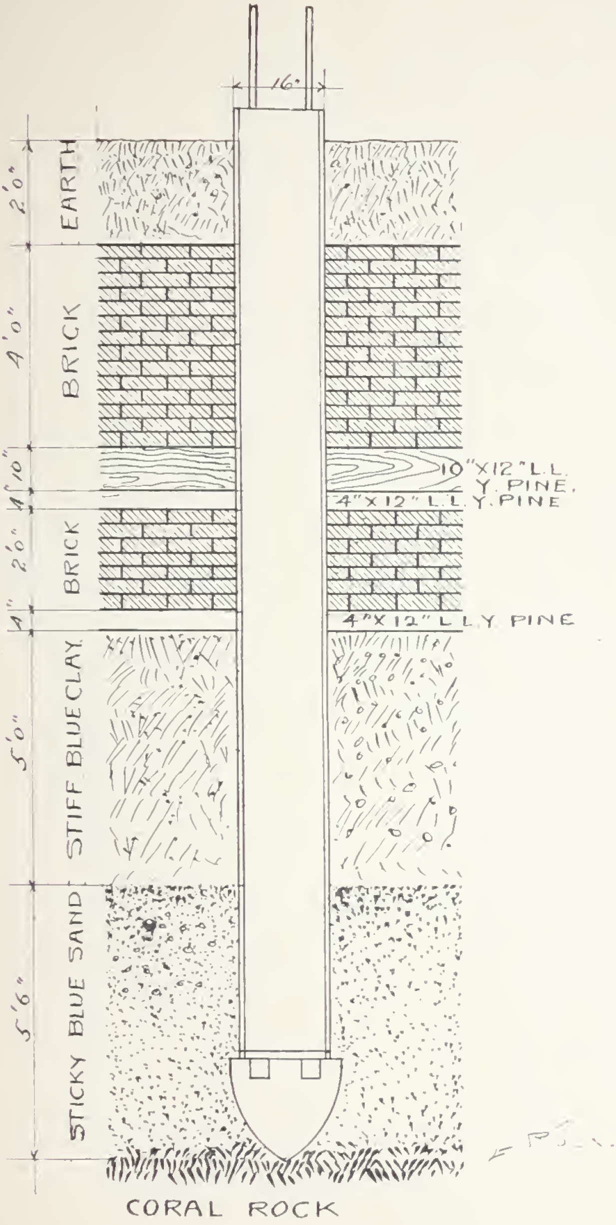
No excessive stress is placed upon the concrete and the reinforcing bars may protrude for continuity, if desired, as the pile does not extend to top of channels. This permits driving heads below grade, or in riparian work below tide, enabling excavation of trenches, etc., after the piles are driven, and placing subaqueous footings without resort to usual costly methods.

SUBSURFACE conditions that may prevent penetration of pre-cast piles driven by any of the ordinary methods are overcome without difficulty by the GIANT method of driving. They can be driven wherever steel can penetrate.

GIANT CONCRETE PILES CANNOT BE BROKEN OR OTHERWISE DAMAGED IN DRIVING.

The following illustration shows how these piles appear after severe driving. Those shown were driven in work for the State of New York (see *Engineering News*, issue of March 2, 1916). Final penetration was 60 blows per inch with No. 1 Warrington steam hammer. (Weight of ram, 5,000 lbs. Stroke, 42 inches.) These piles bear upon rock 25 feet below grade. They are 16 inches square and good for a safe load of 65 tons each.

The driving force applied to Giant piles would quickly shatter the concrete if applied directly thereon. Other methods employ a cushion head to absorb impact, thus dissipating much of the propelling energy and lowering load capacity, whereas this method concentrates the force directly upon the point, and since no cushion is employed, high penetrating power is obtained and consequent maximum load development, as illustrated by the following diagram. See *Engineering News*, issue of Dec. 28, 1916.



Seven hundred and ten 16 inch square Giant piles were driven on this work for the U. S. Government at Wilmington, N. C. Final penetration of the pile shown was 60 blows per one quarter inch with No. 0 Warrington steam hammer. (Weight of ram, 7,500 lbs. Stroke, 48 inches.) Subsurface conditions were such as to make driving by ordinary methods impossible.

LOAD CAPACITY

Load capacity of this pile may be developed up to the full safe compressive strength of the concrete. The enlarged point will safely distribute the load to bearing strata. A considerable amount of earth friction is removed from the surface of the channels by vibration under the rapid hammer blows, while the point projections lessen friction upon the exposed sides of the pile. Accordingly, contrary to all other methods, a larger amount of the driving force is actually employed to propel the pile, thus giving great latitude for depth and high load capacity for either friction or bearing piles. After withdrawal of channels earth friction is rapidly developed, adding accordingly to the load capacity.

By the following method a known factor of safety and uniform load capacity are given to Giant piles—see *Engineering News,* April 27, 1916.

P—Safe load capacity, in pounds.

F—Factor, varying from 12 to 1, and usually taken at 2 giving (when taken at 2) a factor of safety of 6.

W—Weight of striking parts of hammer in pounds.

H—Vertical distance in feet through which striking parts fall.

S—Penetration (set) of pile in inches at last blow. This is to be determined by taking the mean of the sets for a number of blows when the penetration has been at a uniformly decreasing rate.

C—Constant to provide for the increased resistance to moving at moment of impact, taken at 1.0 for drop hammers, and at 0.1 for steam hammers. The constant "C" represents in inches the extra initial resistance of getting the pile into motion again, after an interval of rest due to the force of the last blow being expended.
There is always an increased resistance to motion, and a decrease of set per blow, as an effect of an interval of rest during which earth friction is developed by settlement about the pile.
Use of a constant to compensate for soils of varying consistency and pressures, and of consequent differing mobility, involves a wide margin of uncertainty, with this formula as commonly used. (Wellington Formula.)

$$P = \frac{F\ W\ H}{S + C}$$

Assumption:

Let W—be 5,000 pounds.
H— 3.5 feet.
F— 2.
C— 0.1 for steam hammer.
P— 100,000 pounds.

Solving for required penetration to support 50 tons, according to formula:

$$100{,}000 = \frac{2 \times 5{,}000 \times 3.5}{S + 0.1} \quad \text{or } S = .25$$

Therefore, with S equal to .25, P is 100,000 pounds with a supposed factor of safety of 6. Consequently, ultimate load capacity would be 600,000 pounds, according to the formula.

Assume that settlement starts (upon making a test) at 300,000 pounds, indicating a different factor of safety than that given by the formula. Equate with actual load at which settlement begins, as follows, and solve for F:

$$300{,}000 = \frac{F \times 5{,}000 \times 3.5}{.25 + 0.1} \quad \text{or } F = 6.$$

Now, rewrite formula, inserting the new value of F:

$$P = \frac{6 \ W \ H}{S + C}$$

Equate the formula with the required load, using ultimate capacity (the factor of 6 now not including a factor of safety) and solve for value of S conforming with the test load, as follows:

$$600{,}000 = \frac{6 \times 5{,}000 \times 3.5}{S + 0.1} \quad \text{or } S = .075$$

If it is not practicable to apply a test load to the stage of actual settlement, a lesser load may be used, the formula being also solved for penetration to carry a load proportionately less than the actual required load. The new value of F is then to be inserted and the formula solved for S in an equation using the ultimate required value of P as above. By this means very close approximation is arrived at. In either case, the error due to use of a constant value of C is corrected to meet the actual physical conditions involved. Any factor of safety may be fixed with reasonable certainty.

COST

UNCERTAINTY IN FOUNDATION WORK TO SAVE COST HAS TOO OFTEN RESULTED DISASTROUSLY TO NEED COMMENT. A WORD ABOUT COST OF GIANT PILES, KEEPING IN MIND THEIR UNIFORM INTEGRITY, MAY HOWEVER BE SAID — WHEN THEY ARE PLACED ACCORDING TO THEIR HIGH LOAD CAPACITY, IN COMPARISON WITH ANY OTHER PILE IN USE, THEY WILL NOT INCREASE, AND THEY WILL OFTEN REDUCE MATERIALLY THE COST PER TON OF LOAD SUPPORTED, BECAUSE A LESS NUMBER OF PILES WILL BE REQUIRED WITH RESULTANT SMALLER FOOTINGS AND CONSEQUENT SAVING IN TIME AND COST.

"CONCRETE PILE STANDARDS"

Extract from an article in "Concrete," issue for July, 1917.

Taking a New York City building regulation recently established, very simple analysis is needed to convince one of the ease with which a dangerous lack of safety may pass into approved work. A provision of this law is that concrete piles moulded in the ground are to be not less than 6 inches diameter of point, not less than 11 inches average diameter, and of length not to exceed 30 average diameters. When precast, least point diameter must be 8 inches, least average diameter 12 inches, and length not to exceed 20 average diameters. Loading is allowed for moulded in the ground piles not to exceed 350 pounds per square inch in any part of the pile, while with precast piles loading is not to exceed 500 pounds per square inch upon the area of the average cross section. When practicable to do so, it is required that all piles are to be driven to a solid bearing at their points.

Twenty cubic feet of concrete may be moulded into any one of three different piles, as follows: a tapered pile twenty feet long with diameter of point 6 inches and diameter of head 20 inches; a cylindrical pile twenty feet long and 13.6 inches diameter; a square pile of unvarying dimensions 12 inches on each face and twenty feet long. Each of these piles would comply with the law referred to, if cast in the ground, the tapered pile having 13 inches average diameter, which

is two inches more than the law requires. The tapered pile would be allowed a unit stress at the point of 350 lbs. per square inch, so that it could carry 9,896 lbs. to the strata upon which it stands, with a probable factor of safety of six. Either the square or cylindrical pile would carry 50,946 lbs. to the bearing strata at its point with the same factor of safety. Accordingly, taking into account allowance for skin friction, let it be assumed the three piles under consideration are to each be loaded with 30 tons. The tapered pile will have to carry 50,104 pounds through skin friction, while both straight piles will have to carry 9,054 pounds each through skin friction. The tapered pile has 9,806 square inches frictional area, while the cylindrical pile has 10,255 square inches and the square pile has 11,587 square inches. Therefore, the tapered pile must distribute to the surrounding earth five and one-half times the load of the square pile and with less than eighty-five per cent of the frictional area of the square pile with which to do it. In this connection it is well to consider the effect of the square pile having vastly more frictional area than the tapered pile at its lower part where the earth pressure is greatest, while over thirty-six per cent. of the frictional area of the tapered pile is confined to the first five feet below the surface of the ground where the earth pressure is least. Upon this uppermost five feet of penetration, to maintain the usual factor of safety of six, this tapered pile would have to develop skin friction that would support 4,416 pounds ultimate load per square foot.

What actual factor of safety is involved under these circumstances? No materials are saved; no correct principle of engineering is involved—why then are concrete piles tapered?

Dangers incident to placing wet concrete in contact with unknown subsurface conditions are certainly apparent without discussion. The displacement of such a pile, and consequently its load capacity, will here depend upon whether internal pressure of the shaft of wet concrete, or external earth pressure is in excess, depression or enlargement of the shaft resulting as the one pressure exceeds or is less than the other. Probably the most pertinent danger is that of thrust of an obstruction intercepted by an adjacent pile in course of driving, and the doubtful effect of the intense vibration inseparable from hammer driving upon concrete between initial set and solidification would seem to be a factor whether or not a shell be used.

PILES DEPENDED UPON TO CONCENTRATE THEIR LOADS UPON FIRM BEARING STRATUM AT THEIR POINTS NECESSARILY OUGHT TO HAVE THE GREATEST POSSIBLE SECTIONAL AREA OF POINT. THE LEAST SECTIONAL AREA OF A TAPERED PILE IS AT ITS POINT. HENCE, A TAPERED PILE IS THE LEAST SAFE OF ANY PILE WHEN USED AS A COLUMN.

PILES not driven to load bearing stratum obtain their ability to support imposed loads by reason of the earth friction against their sides.

THIS friction increases with the intensity of earth pressure, and the earth pressure increases in intensity with depth.

PILES that taper toward their points have most frictional area, and most earth displacement, within the upper portion of their length. A round pile tapered from twenty inches diameter at the head to six inches diameter at the point, and twenty feet long, has almost one-half its frictional area and displacement in the five feet of length below the head. Therefore, tapered piles compress the top stratum most, and the bottom stratum least; having least frictional area at their deepest penetration, and most just below the surface of the ground, they develop least load capacity from the natural earth compression about their points, and most load capacity from the artificial compression of the earth about their heads, and THIS IS DIRECTLY OPPOSITE TO THE REASON THAT REQUIRES PILES, viz.: that the uppermost stratum will not safely support the loads. The uppermost stratum is liable to alteration of its supporting value in much greater extent than the deep underlying strata, and a very slight change of this nature would develop a very large change in the supporting value of a pile that has nearly one-half its load capacity concentrated in the uppermost five feet of penetration.

A frequent consideration relative to the type of pile to be employed is—time required to place. The question is—would you subject green concrete in the superstructure to stress that could be avoided? If so you would watch closely for resultant strain, and you could see and remedy a defect developed therefrom—but it is better not to take such a chance. No matter how much

skill is employed toward the perfection of the superstructure, failure of the substructure (the piles) will destroy the work above. With this in mind, is it good practice to subject the green concrete of cast-in-the-ground piles to a stress, the result of which you cannot detect—with a consequent danger of destroying the entire structure? Whether the piles be of either type, the concrete ought to be thoroughly seasoned before loads from the superimposed structure are applied, so that the time required to place GIANT CONCRETE PILES, within limits of ordinary safety, is the same as that required to place inferior cast-in-the-ground piles, and less than that required for any other pre-cast pile. From fifteen to thirty per day are driven with one pile driver.

GIANT CONCRETE PILES HAVE ENLARGED POINTS OF CAST IRON, MADE UPON THE PILE.